



Scottish Development International

SUBSEA TECHNOLOGY SCOTLAND

Dec 2014

Akira Matsueda – SDI

Murray Bainbridge- SDI

Scott Wilson – Scottish Enterprise

Introduction & Background

Ocean Industries

Subsea Industry

Key Subsea Companies

Key Research Capabilities

Education and Training

North Sea Future Strategy



Introduction & Background

- **Scottish Enterprise**
- Economic Development Government Agency
- **Scottish Development International**
- Inward Investment & International Trade
- Sustainable Economic Growth
- Innovation and Technology Development



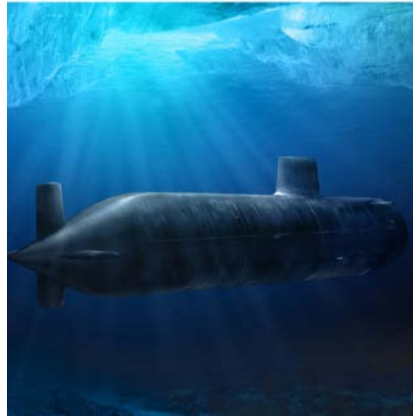


Ocean Industries in Scotland

Ocean Industries in Scotland



Aquaculture



Defence



Offshore Wind



Fishing



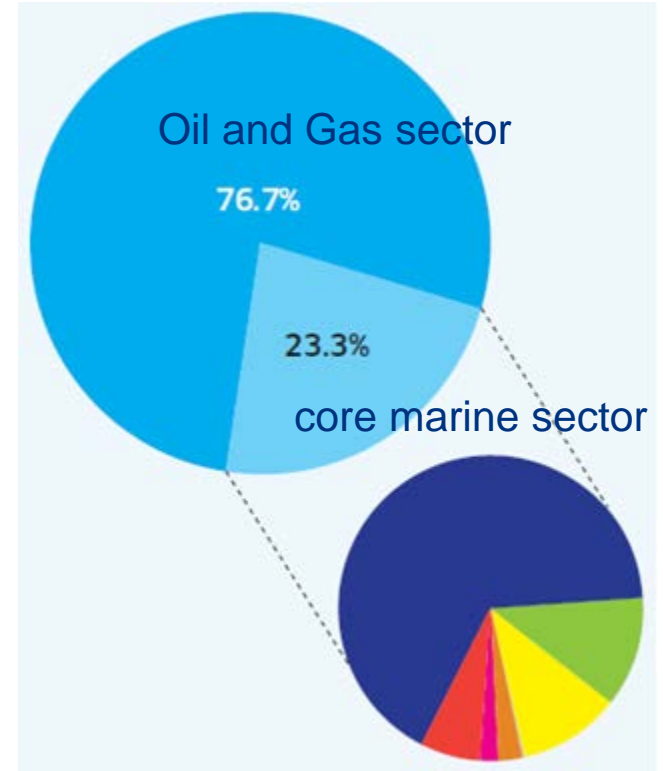
Subsea Oil and Gas



Wave and Tidal

Ocean Industries in Scotland

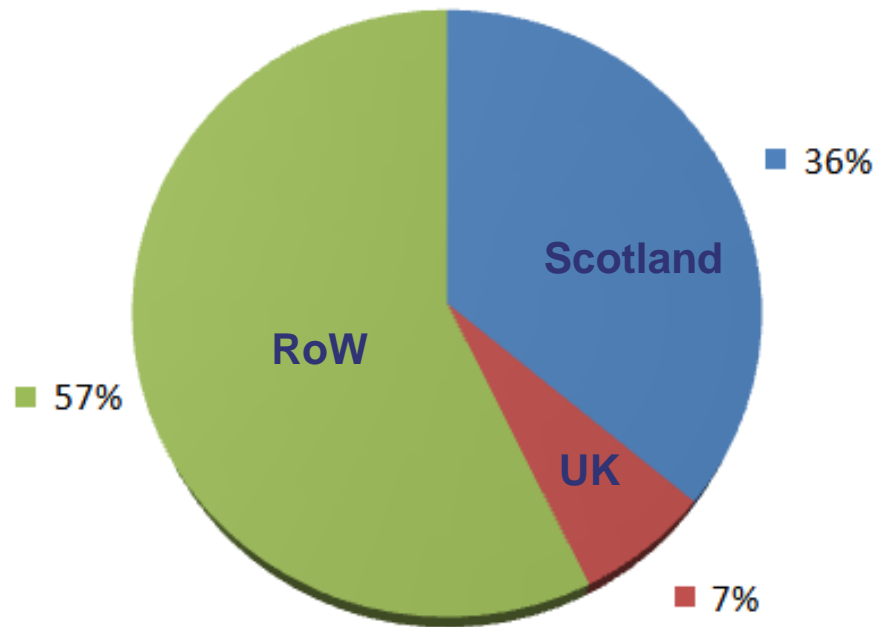
- Ocean industries sector approx £33B of turnover (¥5.6T)
- Oil and Gas sector approx £25Bn (¥4.2T)
- Around 4000 employed in the core marine sector
- Of these, 30% were employed in seafood and fishing





Subsea Industry in Scotland

Subsea Sector Output



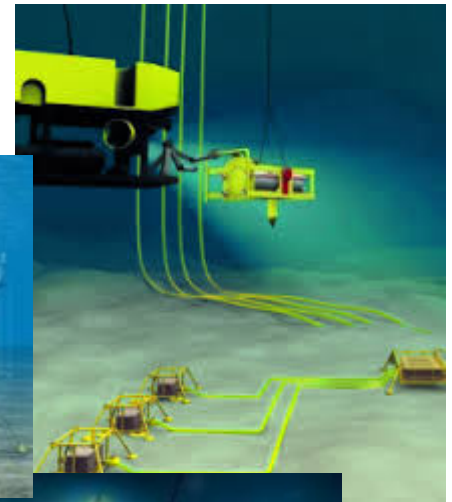
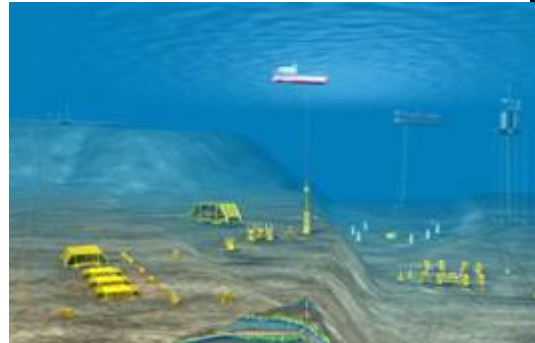
- Scottish Output over £7.5 billion
- 36% of world subsea market
- Growth is due to both export and domestic market.
- North East Scotland dominates output due to presence of large contractors.

Global Subsea Market £21 billion (¥3.5T)

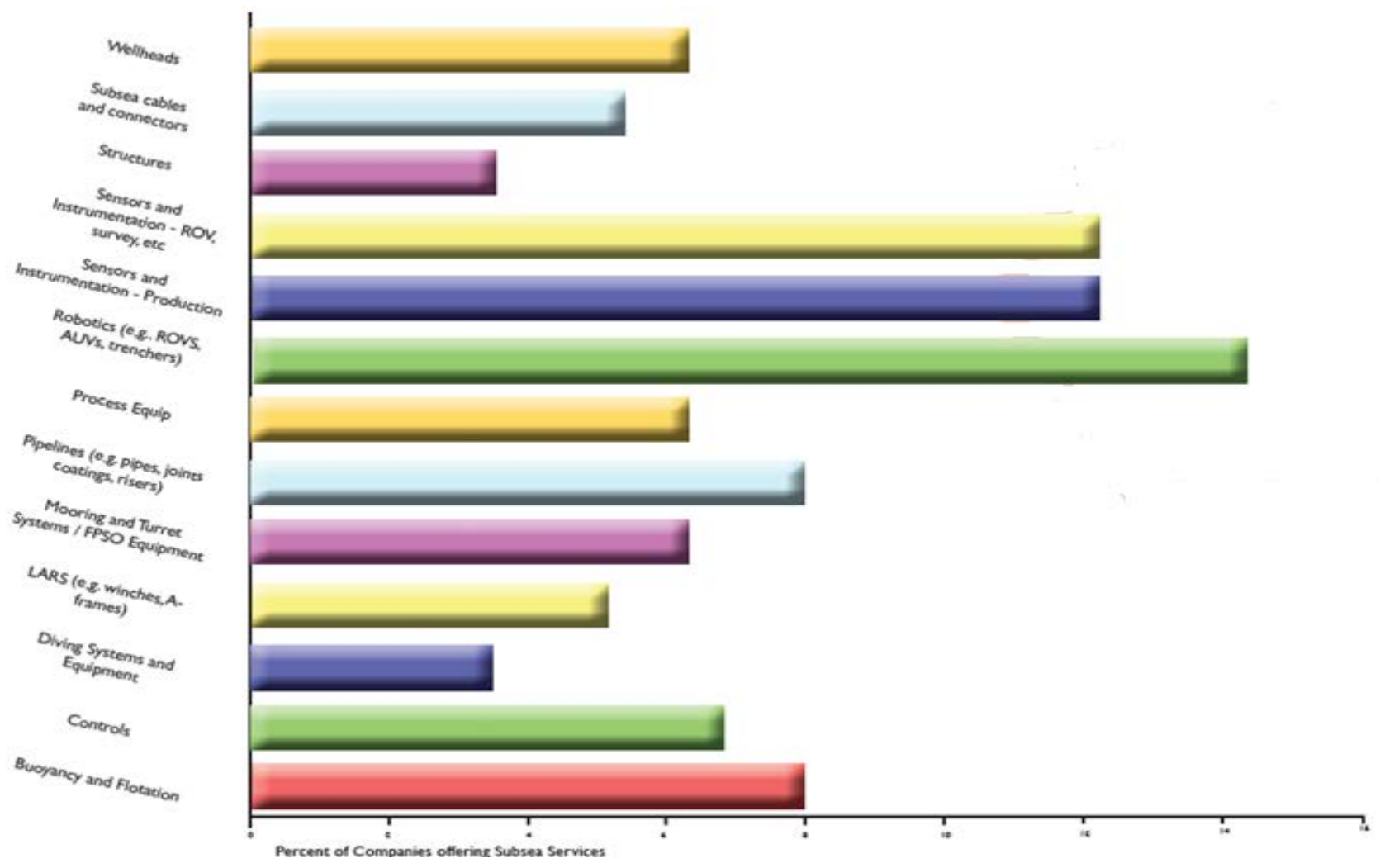
Expected to double over next 5 years

KEY FACTS

- The subsea sector in Scotland is worth an estimated £7.5B per annum (¥1.2T)
- 370 subsea companies, employing over 38,000 people
- Serving multiple sectors:
 - Oil & Gas
 - Defence
 - Renewables
 - Shipping
- Range of specialist activity areas:
 - Manufacturing
 - Consultancy
 - Services



SUPPLY CHAIN – percent of companies offering





Key Subsea Companies Profile

SUBSEA GLOBAL SERVICES COMPANIES IN SCOTLAND



TOTAL



GE Oil & Gas



KONGSBERG



ConocoPhillips

Schlumberger



Aker Solutions™

TALISMAN
ENERGY

subsea 7®



CHIYODA
CORPORATION

HALLIBURTON



Technip



Statoil



CAMERON

DCF subsea



HELIX
ENERGY SOLUTIONS GROUP

BIBBY
OFFSHORE



Hallin
A SUPERIOR ENERGY SERVICES COMPANY

mcs kenny



EXPRO

bp



xodus
GROUP

FMC Technologies

- Global leader in the supply of ROV and bespoke tooling services to the subsea sector
- 40 years of ROV experience and an intensive Research and Development programme with R&D teams located globally including Aberdeen
- Design, build, operate and maintain exclusive, globally available pool of subsea tooling solutions
- Setting industry standards adopted by operators across the globe
- Fleet of vehicles suited to survey and inspection services aided collaboration with survey and inspection departments in Subsea 7

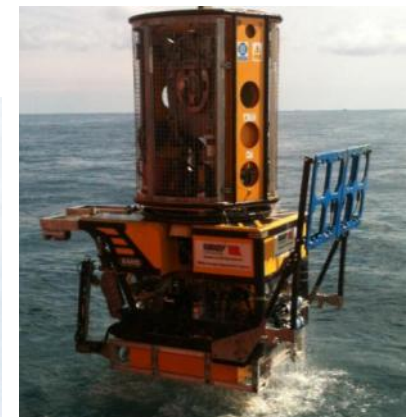


- subsea production systems for pressures up to 15,000 psi and water depths up to 10,000 ft.
 - subsea trees,
 - wellheads
 - production and processing systems,
 - surface wellhead systems,
 - high pressure fluid control equipment, measurement solutions
 - marine loading systems
- R&D facility of 250 people for the development of technologies such as
 - optical spectroscopy,
 - optical fiber sensing
 - wireless communications,
 - fluorescence leak detection



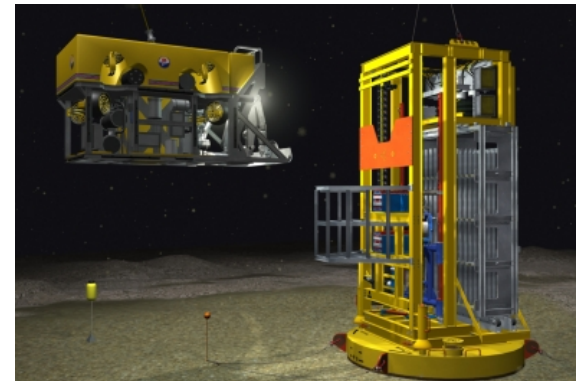


- subsea construction, inspection, repair and maintenance
- surface vessel support fleet with permanent subsea deep dive and ROV capability
- long track record of successful delivery:
 - Flexible flowline, umbilical installation and tie ins
 - Riser installation
 - Structure installation (WHPS/PLETS/PLEMS etc)
 - Diver and ROV supported tie ins
 - Diverless construction activities
 - Deepwater IRM
 - Pipeline inspection services



Company Overview – Forum Energy Technologies

- World leading product manufacturing, and engineering group incorporating a number of global brands across the subsea industry
 - Sub-Atlantic: leading manufacturer of Comanche, Mohican, Super Mohawk, Mohawk, Mojave, Tomahawk and Navajo Electric Observation ROV Systems and subCAN high speed communications data network system
 - Rovdrill: specialized drilling and assessment system enabling successful deepwater drilling and exploration, in situ testing and coring tasks on the seabed and easy integration with most work-class ROV systems
 - Visualsoft: ROV control and simulator software suite



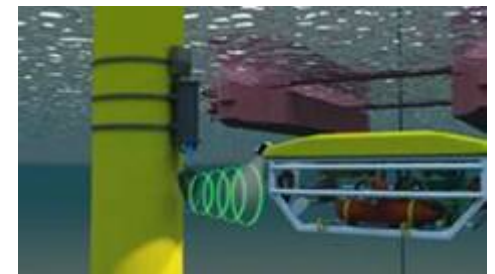
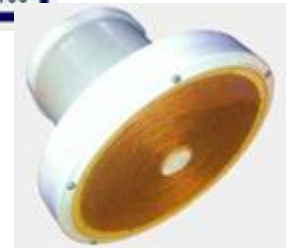
- world leading manufacturer of remotely operated vehicles (ROV) and underwater inspection systems and products

AC-ROV 100 and 3000 Features

- weight of just 3kg at 204mm x 151mm x 146mm.
- applications, offshore, onshore or down pipes,
- one person can easily deploy the system in less than 3 minutes
- can also be controlled with one hand,
- 5 degrees of freedom equal forward and lateral thrust
- application is Commercial, Security, Emergency or Recreational
- depth rating 100m and 3000m



- world's leading supplier of through-water and through-ground wireless technology for communication, navigation and power transfer.
- signal can penetrate water, air, across the air/water interface and even through solid material (seabed, ground, harbor walls, ice) to allow two-way comms at high data rates and with low latency. (~156kbps @ 4m -7m))
- applications include data transfer between underwater sensors and unmanned underwater vehicles (ROVs and AUVs) and Wireless Pan Tilt Zoom Camera
- inductive charging function to sensors, data loggers, control systems and AUV docks - wirelessly. 10W – 3kW at up to 90% efficiency at up to 30cm – No wet mate connection needed



- Underwater Vision Specialists
- Design, Manufacture and Supply....
 - Visual inspection systems and controllers
 - Xenon underwater strobes
 - Subsea electrical and fiber optic connectors
 - ATEX certified explosion proof systems
 - Pan/Tilt/Zoom colour cameras
 - Underwater LED lighting
- Customers across Subsea, ROV , AUV, Oil and Gas, Defence, Nuclear, Oceanographic Research and Marine Science industries



- Manufacture high quality underwater video and communications products for offshore and ROV industries
- Design and supply of electronic equipment for marine environments
- Underwater video systems to suit most diving and ROV requirements
- Underwater LED lighting and subsea scaling laser modules
- Supply and services to:
 - Oil & Gas
 - Military
 - Scientific



NASNet

- subsea positioning system combining long baseline & GPS concepts upto 5000m depth and 10Km range

NASCOM

- wireless systems for BOP with world first acoustic MUX

NASDrill

- vessel riser / anchor positioning using spread spectrum

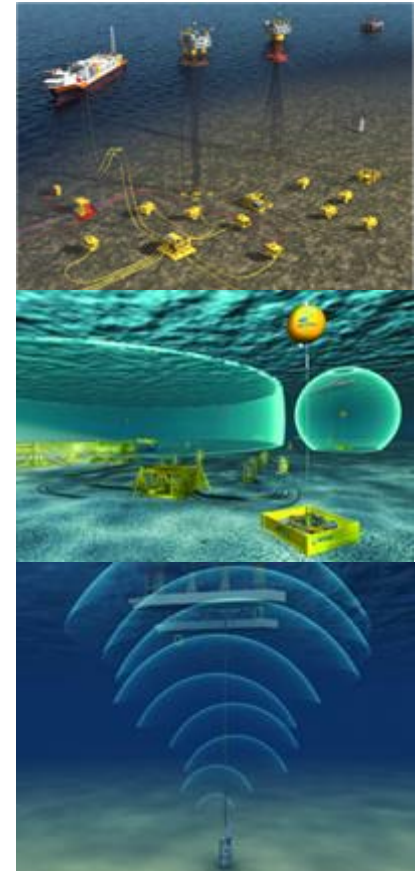
NASDive

- Diver Communications - unscramblers , Emergency through water

NASeBOP

- acoustic control system to meet the requirements of mission critical BOP

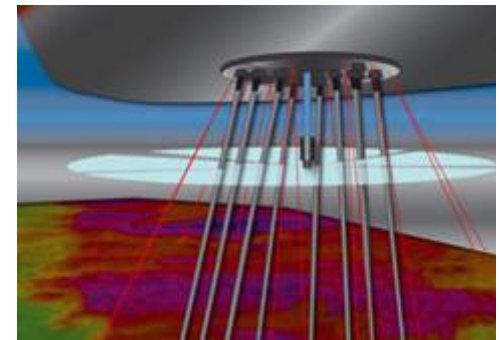
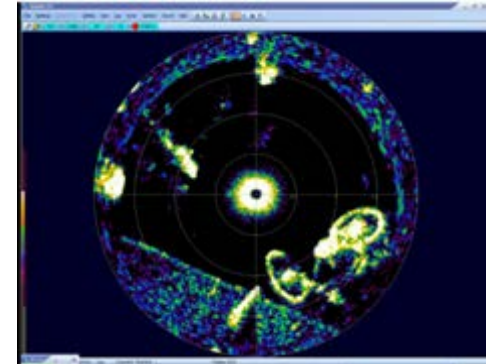
- Pig Tracking – magnetic Pig signallers



- Piezo-composite technology in both sonar and NDT.
- customize Piezo-composite Transducers and Arrays, employing state of the art design and manufacturing techniques.
- in-depth understanding of materials and processes for operation in the most demanding and harsh environments.
- mechanical, electrical and acoustic design capability allows them to work closely with their clients to optimize every aspect of the transducer design.



- specializes in high performance sonar, video cameras for Energy, Defence , Security, Engineering, Survey, R&D
- multibeam, scanning, profiling, bottom profilers, side scan, bathymetric systems, altimeters, FPSO, littoral zone
- Digital Sonar Technology , CHIRP
- riser and anchor monitoring system is a 360° riser and anchor chain monitoring system for FPSOs beneath the vessel to monitors the presence, integrity and position of mooring lines and risers 24/7 from a single sonar head.



- advanced awareness control systems for unmanned systems AUV and ROV, integrated technology into land, air and sea solutions.
- first autonomous inspection of riser pipes using ROVs
- first AUV autonomous docking technology using sonar / video
- world-record held for AUV pipe tracking demonstrated in the North Sea - 22 km autonomous tracking
- first commercially available automatic manmade underwater object-identifying software using side-scan
- partnerships with Subsea 7 for AIV system



[Video](#) AIV platform with Subsea 7

- **Biomimetic wideband pulsed sonar** based on Dolphin capability for object identification in shallow cluttered waters

- **Standard sonar** - Increasingly high frequency, limited range, external view only black and white, intensity only, size; shape

- **Biosonar** – Wideband (30kHz to 150kHz) , Lower frequency,

- **See what's inside**, more informaton

acoustic colour; texture, material; composition, contents; condition



- Inertial Navigation for both Subsea and Surface (Offshore and Onshore) applications,



- High Accuracy GPS Positioning Systems
- Remote & Topside Data Collection,
- Attitude (Heading, Pitch & Roll Sensors)
- Sensing, Data Transfer,
- Multiplexers



Smallest Fiber Optic Gyro in world

- World's First 3D Scanning Subsea LIDAR



OceanSense leak detection systems

- Photo multiplier 50 times as sensitive as conventional “black light” detectors
- ROVs lights do not have to be turned off – improved safety
- Detection range up to 7m
- Results visible both on camera and via software
- Detects wide range of dyes & substances
- No dangerous lasers



- Fiber optic gyrocompasses
- ROV video overlays
- Pan and tilt units
- Subsea displays
- Heading, attitude and tilt sensors

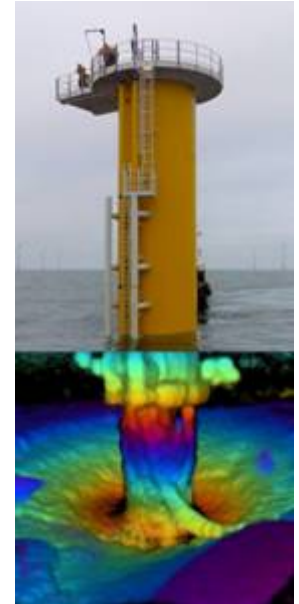


Underwater Camera Systems up to 8000m depth

- Harsh Environment CCTV Systems:
- Offshore Drill Support CCTV
- Commercial Vessel CCTV
- Naval Ships CCTV, Submarine CCTV
- Naval Underwater Vehicle and Diver Deployed Cameras



- 3D Real Time Sonars – Echoscope® and Dimension®
 - Instantaneous, high definition real time 3D sonar
 - 3D scene completely updated at up to 20 Hz
 - Up to 3000m depth
 - Single or dual frequency sonar
 - Up to 16,000 beams using phased array
 - Marine construction, dredging, oil and gas, port and harbour security, ROV & AUV
- Marine Geophysical Survey
- Motion Sensing



Company Overview – Caley Ocean Systems



Caley Ocean Systems supplies innovative and bespoke offshore handling systems, design consultancy, professional project management and engineering services to the offshore oil and gas and renewables industry, ocean science and naval defence markets.

Offshore Products



- High Capacity Carousels, Turntables and Spoolers
- Pipe and Collar Clamps
- Storage Reels
- Pipe and Cable Tensioners
- Caley Winches
- ROV / AUV Handling
- Dive Bell Handling Systems
- The Caley Davit

Ocean Science



- Manned Submersible Handling - Stern A-Frames
- A-Frame Handling Systems
- CTD Handling Systems
- Winch Systems

Naval Defence



- Submarine Rescue Systems
- Autonomous Undersea Vehicle (AUV) Handling System
- The Caley Davit



- designs and manufactures world-leading electro-optic night vision systems and equipment.
- supplier of periscopes and optronic masts for Royal Navy's and Japanese submarines
- supplied most of the UK's armoured fighting vehicles with night vision equipment.
- design and manufactures reconnaissance pods, and Infra-Red Search & Track for the Eurofighter





Submarine Rescue Products



DSAR Class Sub Rescue Vehicle



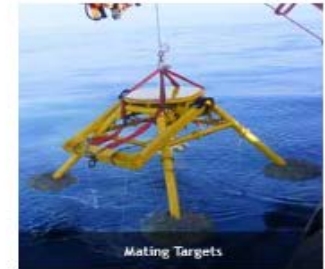
Launch & Recovery Systems



Submarine Rescue Bell



Transfer Under Pressure Systems

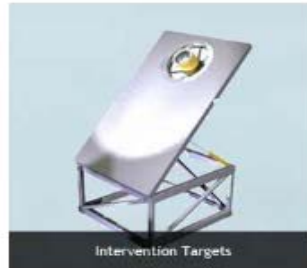


Mating Targets

Submarine Intervention Products



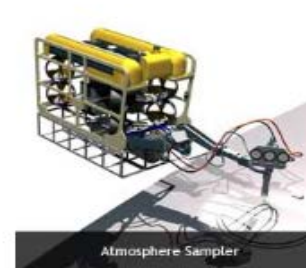
Flyaway ROV



Intervention Targets



ELSS Pods & Bags



Atmosphere Sampler

The SEAL Pod



SEAL Carrier



Sub SEAL



Torpedo SEAL



MARINE RENEWABLE ENERGY



SRSL facilitates the sustainable development of marine renewable energy generation in Scotland through world-class environmental surveying, sampling, monitoring and analysis

MARINE TAILINGS DISPOSAL



The world's leading environmental consultancy in Deep-Sea Mine Tailings Placement (DSTP) with over ten years of experience in providing marine environmental impact assessments

AQUACULTURE SERVICES



SRSL deliver expert advice in Integrated Multi-Trophic Aquaculture, Biosecurity Planning, Macroalgal cultivation techniques and feasibility studies, as well as marine growth assessments and field testing of anti-fouling coatings and technologies.

MARINE SERVICES



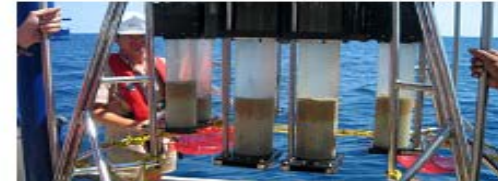
Specialist marine consultancy and survey services, underpinned by cutting-edge science to enable the sustainable exploitation and management of the marine environment



Deep Sea Mine Tailings Placement (DTSP)



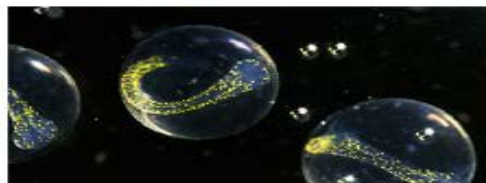
Ecological Surveys



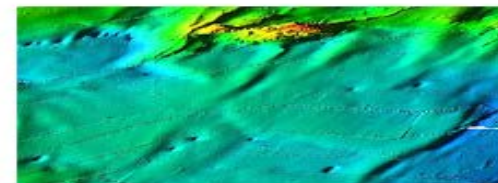
Sediment and Water Quality Sampling



Oceanographic Surveys



Ecotoxicology

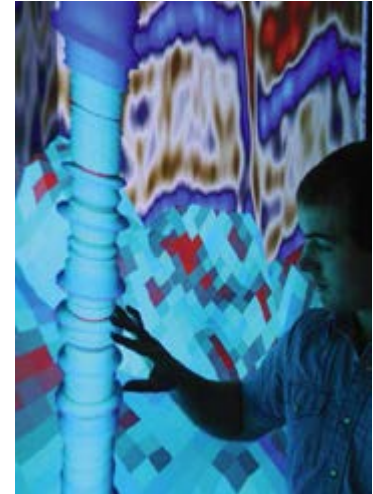


Seafloor Mapping



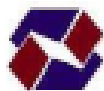
Key Research Capabilities

- exploration training environment preparing geoscientists
- state-of-the-art technology for exploration
- visualisation facilities gifted by Halliburton
- supported by:



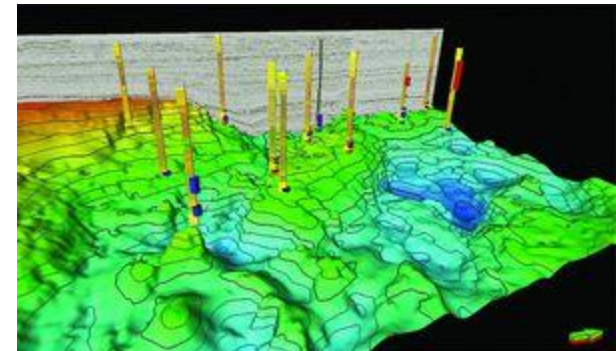
HALLIBURTON

Schlumberger

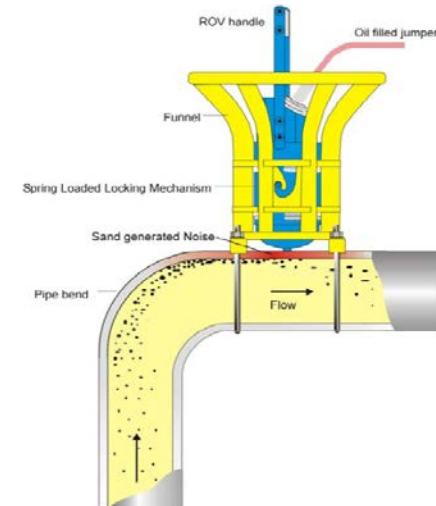


Dana Petroleum plc

GDF SUEZ



- technical consultancy, research, testing, **flow measurement**
- developing technologies for subsea water quality measurement including
 - Laser Induced Fluorescence
 - Image Analysis
 - Particle Detection
 - Ultrasonic Acoustic Measurement



- Industrial Collaborative R&D Club
- facilitating collaborative technology innovation and deployment in the oil & gas sector
- subjects have included
 - subsea communications,
 - AUV inspection,
 - petro-physics,
 - seismic acquisition,
 - geomechanics,
 - sand control
- supported by most of the major producers and support services companies



TOTAL



PETRONAS

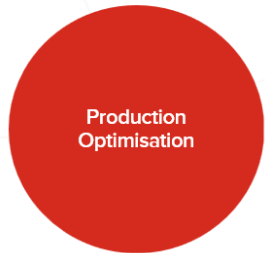
Schlumberger

ExxonMobil

Research Overview –Subsea Research Initiatives

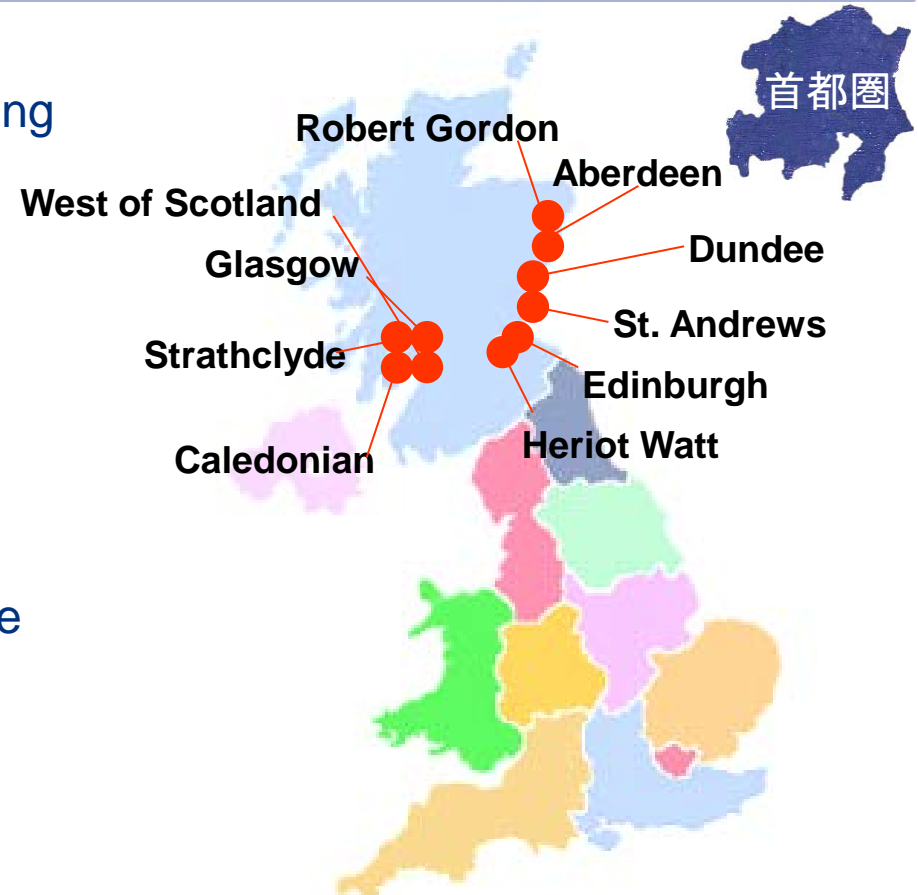


- a direct link between the subsea community and academia as well as government
- facilitate the development of subsea technologies



- collaboration between industry and academia

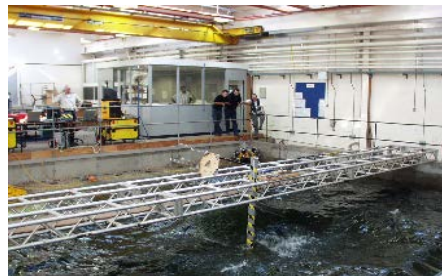
- Around £200M worth of research ongoing in Scottish Companies and University in sensors every year
- CENSIS is interface with 90 research groups
- source of world class domain knowledge and expertise in sensor product development



Ocean Systems Laboratory

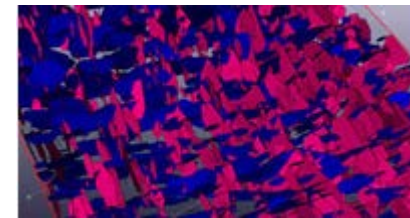
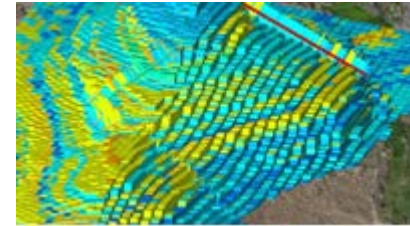
Prof Brown, Prof Lane, Prof Petillot

- bio inspired sonar systems, AUV planning prognostics
- subsea robotics, computer vision, image and signal processing, autonomous vehicles.
- sonar design, data fusion and underwater robotics, autonomy for unmanned platforms
- Oil reservoir modeling, sensing and evaluation



Institute of Petroleum Engineering – 22 Professors

- Carbon Capture and Storage
- Carbonate Reservoirs
- Enhanced Hydrocarbon Recovery
- Hydrate-Phase equilibria
- Multiscale Modeling and flow simulation
- Petroleum geosciences and reservoir geophysics
- Production technology and chemistry
- Uncertainty quantification



Centre for Ultrasound Engineering – Prof Gordon Hayward

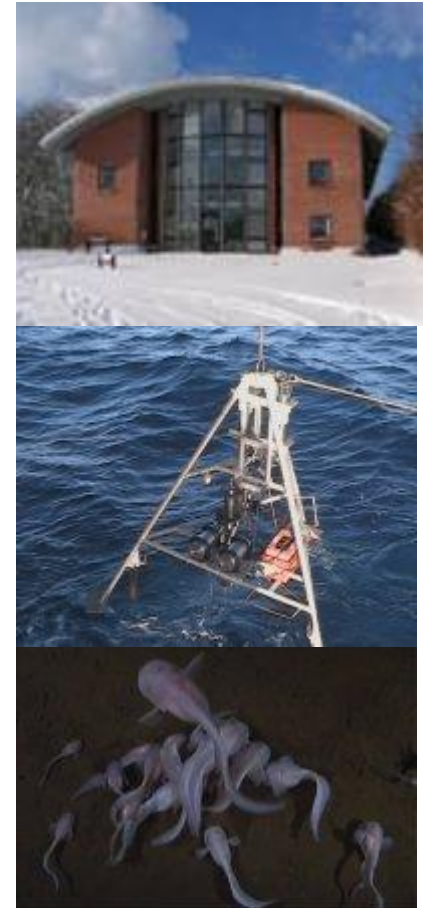
- world leader in the development of transducer arrays
- wideband piezoelectric composite technology to high frequency sonar applications encompassing both military and commercial applications
- sonar applications in the frequency range 50 kHz to 1 MHz
- Ultrasonics, Sonar, NDT, Medical Ultrasound Imaging



- Prof Neilson, Prof Wang, Prof Watson , Prof Allen
 - subsea quantum gravity gradiometers
 - subsea digital holographic imaging
 - wireless sensor networking for subsea
 - laser induced breakdown spectroscopy
- Prof Pollard, Prof Prabhu, Prof Steel
 - subsea molecular sensing, taggants, leak detection
 - fibre bragg integrity monitoring
 - ultrasonic pipeline inspection systems



- unmanned robot LANDERS used for data collection rated to 12,000m
- engineering laboratories, high pressure chambers, vibration tables, immersion tanks and all facilities needed to design, build and test deep-sea systems
- high pressure test vessel for testing subsea equipment and certifying housings to 7,000m depth
- **world-record for a remotely-controlled dive to 10.5km depth** in the Pacific Ocean trench,
- recording video of the world's deepest living creatures with **Atmosphere and Ocean Research Institute at University of Tokyo**



Research Theme 1: ARCTIC SEAS

Using observations, experiments and models to investigate system changes in the Arctic

Research Theme 2: DYNAMIC OCEANS

Investigating fundamental processes and patterns in the oceans relating to climate

Research Theme 3: MARINE RENEWABLES

Delivering independent and innovative research to underpin sustainable marine energy production

Research Theme 4: PEOPLE & THE SEA

Planning and managing our use of the marine environment in a sustainable way

Research Strategy

2013-2018 Research strategy

Our Departments

Biogeochemistry and Earth Science

Ecology Department

Microbial and Molecular Biology

Physics, Sea Ice and Technology

Research Centres

Marine Bioenergy Scotland

Centre for Sustainable Coasts

Centre for Industrial Ocean Impacts

Centre for Smart Observation

Culture Collection of Algae and Protozoa

National Facility for Scientific Diving

Other research areas

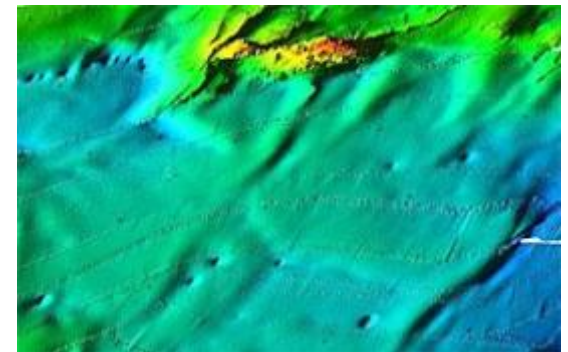
Deep sea research
Aquaculture research

Facilities and Capabilities

Conference facilities
Research vessels
Analytical capabilities
Modelling capabilities
Research aquarium
Library facilities

Scientific Staff

Adams, Dr Tom
Alexander, Dr Karen
Aleynik, Dr Dmitry
Anderson, Dr Phil
Benjamins, Dr Steven
Black, Professor Kenneth D.
Brennan, Ruth
Burrows, Professor Michael
Calder, Dr Lois
Carboni, Stefano
Cook, Dr Elizabeth
Cottier, Dr Finlo
Crocket, Dr Kirsty
Cunningham, Dr Stuart
Dale, Dr Andrew
Davidson, Professor Keith
Day, Dr John
Ditchfield, Dr Arlene





Subsea Education and Training

• Strathclyde University - MSc Subsea Engineering

- Inspection and Survey
- Offshore Engineering Practice
- Risers and Mooring Lines
- Subsurface Technology
- Marine Pipelines
- Maritime Safety and Risk
- Subsea Systems and Installation
- Dynamics of Floating Offshore Installations or
- Computational Free Surface Hydrodynamics or
- Theory and Practice of Marine CFD



- **Robert Gordon University : Introduction to Subsea Engineering**

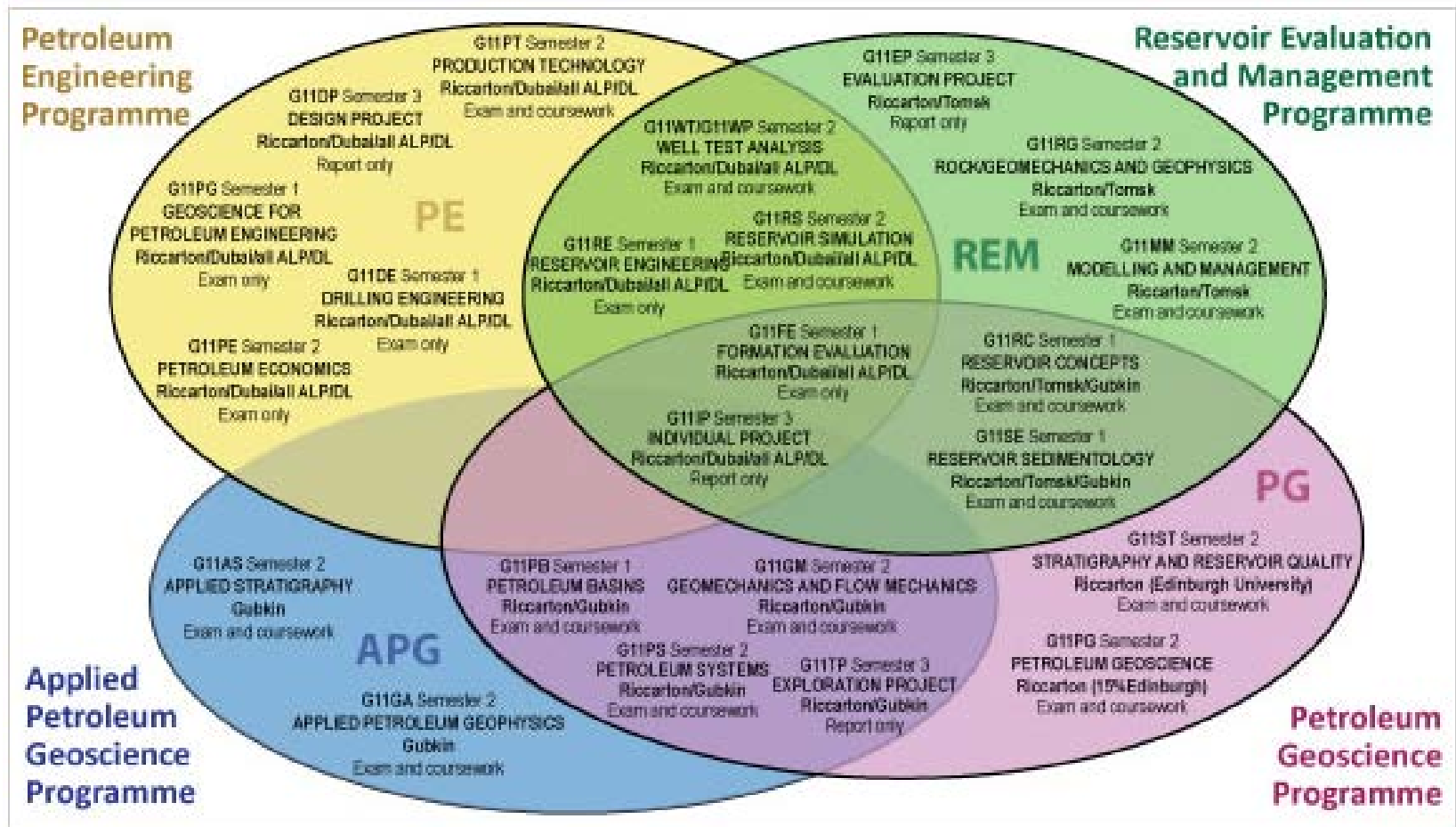
- Distance learning
- Subsea as an industry,
- the basic elements of the oil and gas industry for those new to the industry,
- the components used in subsea completions, production of fluids, interventions, flowlines, manifolds, wells or multiwells.
- Subsea Completions, control systems, flow assurance, pipeline fundamentals, installation, umbilicals, power cables, risers and topsides, new systems
- Subsea boosting to enhance oil recovery from marginal and depleted reservoirs
 - The development of lightweight risers and pipes for deepwater applications
 - Thermal management of pipelines to assure flow
 - Post-Macondo oil spill response technology

- **University of Aberdeen : MSc Subsea Engineering**

- 27 month distance learning or 12 month onsite
- accredited by the Institute of Marine Engineering, Science & Technology (IMarEST) and Institution of Mechanical Engineers (IMechE), the Institution of Civil Engineers (ICE), the Institution of Structural Engineers (IStructE), the Institute of Highway Engineers (IHE) and the Chartered Institution of Highways & Transportation (CIHT).
- understanding of the development and operation of subsea technologies and systems, from wellhead to topside structure interconnections.
- Subsea Production Systems
- Fundamental Safety Engineering & Risk Management Concepts
- Subsea Control
- Subsea integrity construction inspection and maintenance
- Pipeline, soil mechanics, riser systems, hydrodynamics, flow assurance

• MSc Petroleum Engineering and Geosciences

- running since 1975, Distance learning or onsite 4 programmes. CPD short programmes





North Sea Future Strategy

Centres of Excellence

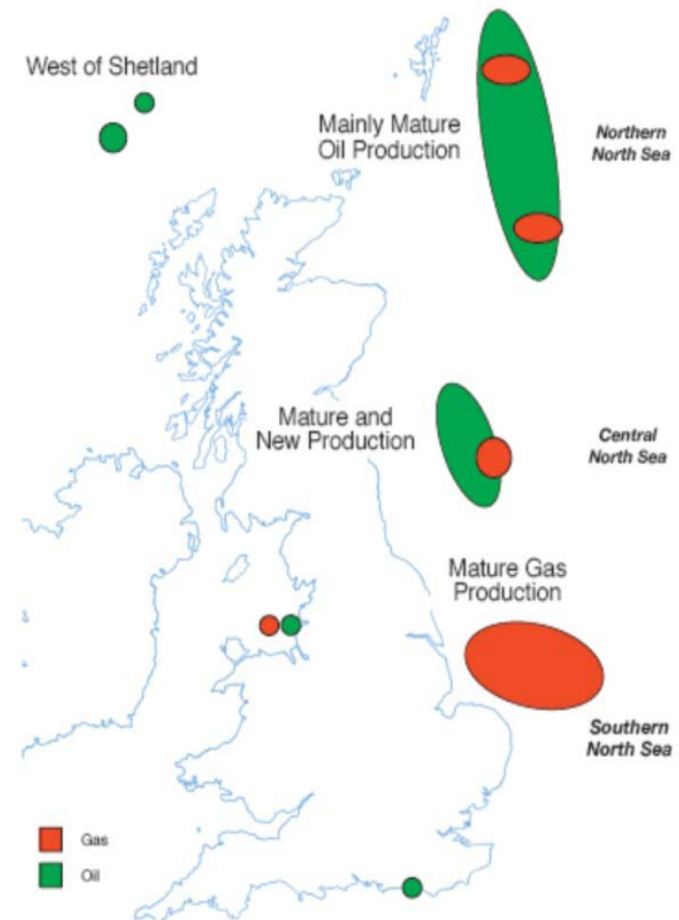
A long tradition of innovation and 15 universities allow Scotland to consistently punch above its weight as a destination for world leading R&D operations.

- Some examples of internationally excellent or world-class oil & gas research capability in Scotland are:

Resonance Enhanced Drilling research	Aberdeen University
Mineral law and policy	University of Dundee
Gas Separation research	University of Edinburgh
Materials/nanotechnology research	Glasgow University
Flow Assurance	Heriot-Watt University
Drilling simulator	Robert Gordon University
Environmental Studies	St Andrews University
Asset integrity	Strathclyde University

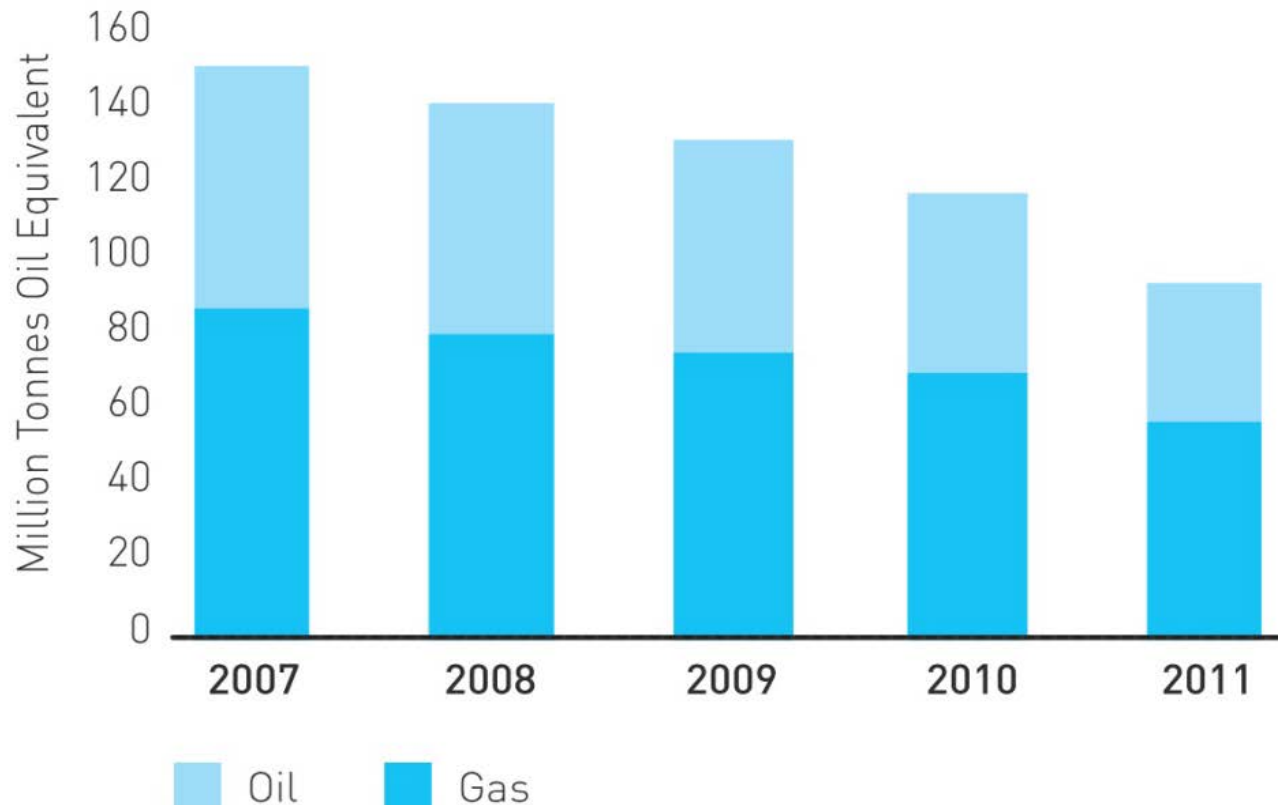
UKCS Evolution

- Gas production started SNS in late 1960s – 50 metres
- Oil production started NNS in mid-1970s – 200 metres
- West of Shetland started late 1990s – approx 500 metres
- Atlantic margin – between 1500 - 5000 metres



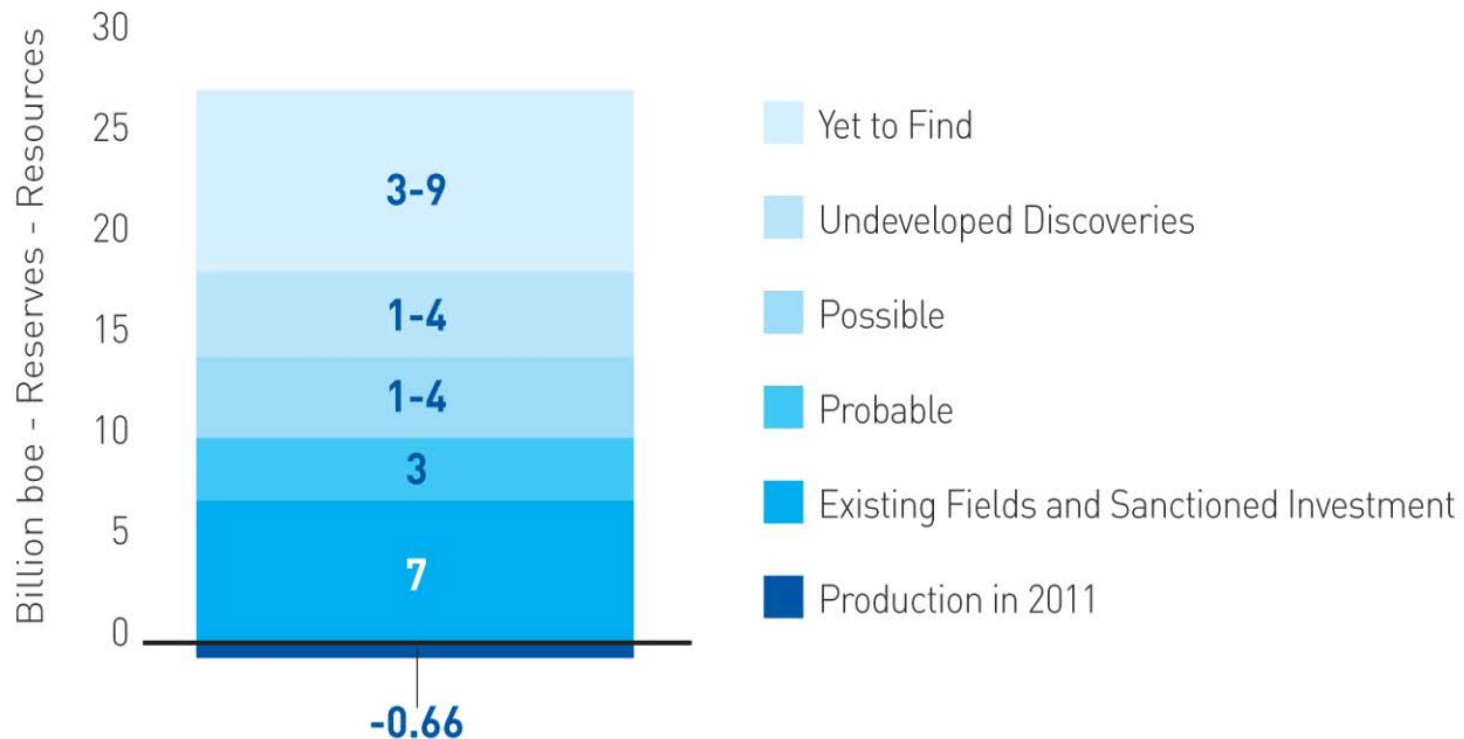
UKCS Production

- UK is in the top 25 global producers of both oil (25th) and gas (22nd)
- Produced 1.44 million boe per day in 2012



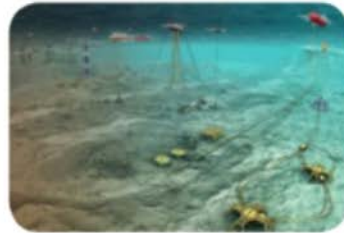
UKCS Reserves

- Up to **24 billion boe** still to be recovered
- **Technology and investment** key to unlocking potential



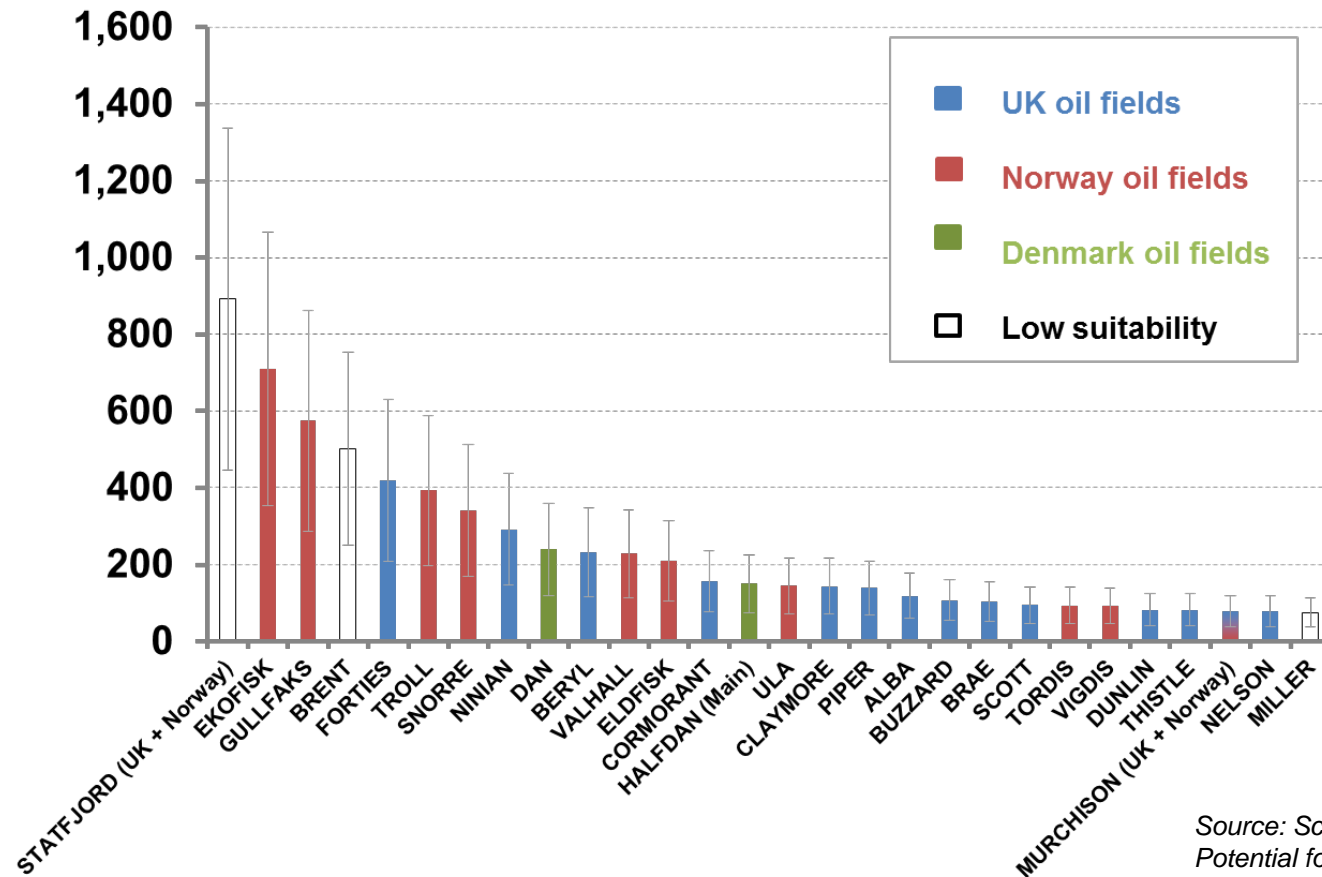
Industry Strategy

- Oil & Gas Industry Leadership Group
- Vision – Maximising Resource Recovery



CO2-EOR Potential

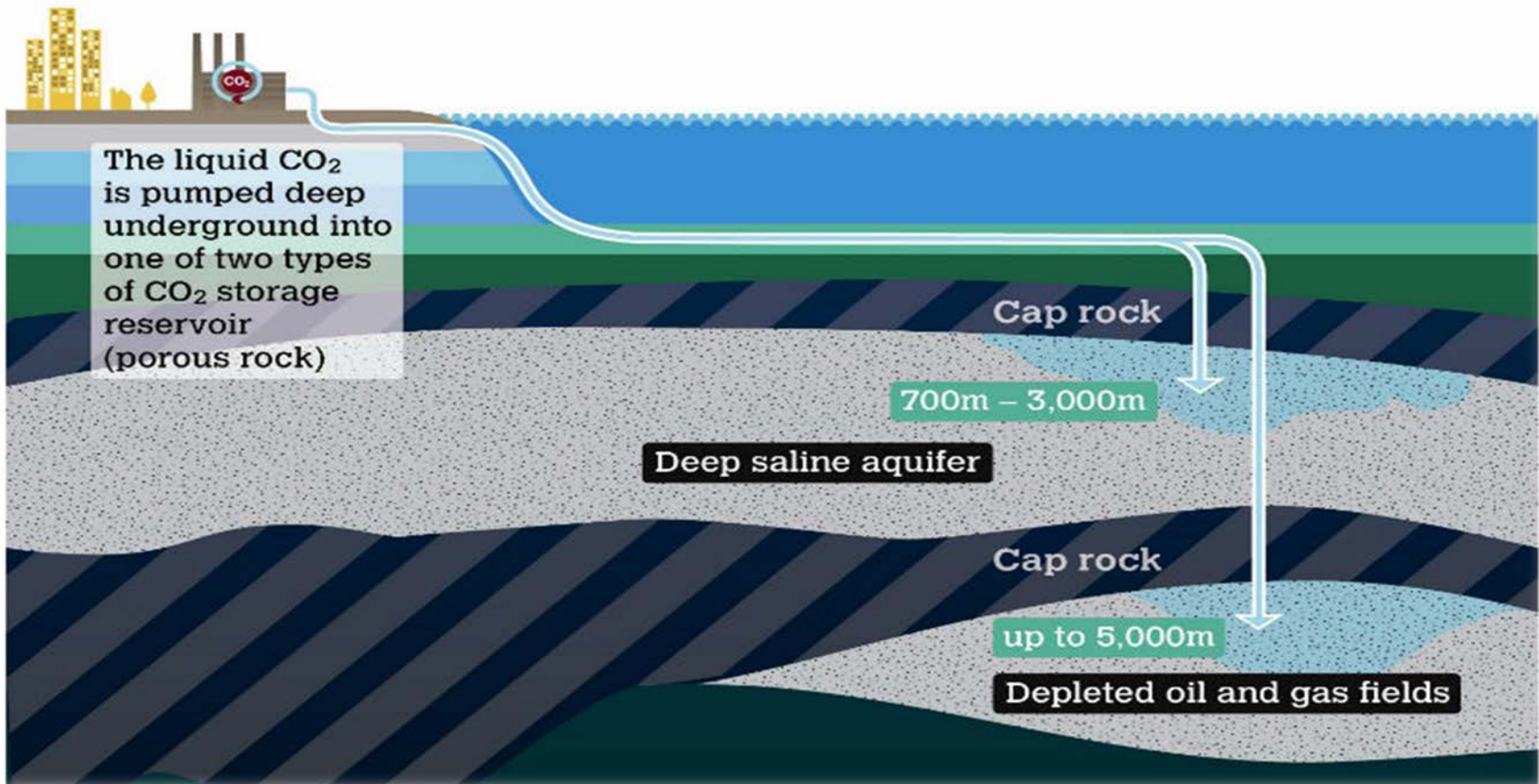
The most likely technical incremental oil potential for CO₂-EOR exceeds 5 billion barrels, dispersed across the UK, Norwegian and Danish sectors of the North Sea.



Source: Scottish Enterprise – CO₂-EOR Potential for Scotland

Carbon Capture and Storage (CCS) - Overview

Safely Storing CO₂



Source: Gov.UK, Peterhead Project

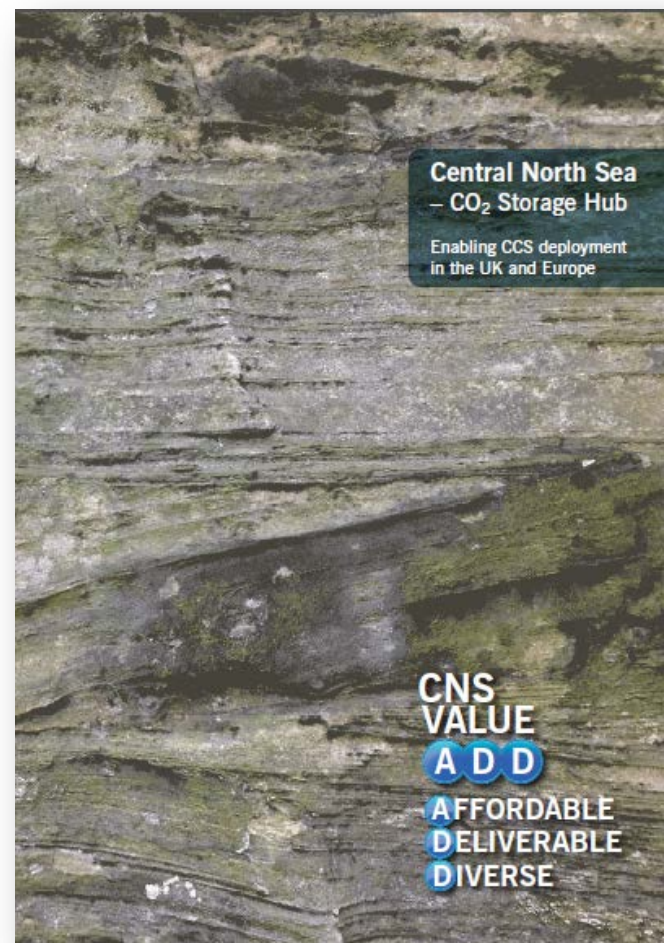
The Vision of a CCS Hub

“The Central North Sea can produce multiple CCS projects quicker than anywhere else in the UK.

The CNS fulfils the UK’s own needs, and also opens a gateway to Europe, to safeguard high value jobs in the UK and provide long-term taxable revenue”.

Prof. Stuart Haszeldine, Research Director SCCS

Sets out the vision of the Central North Sea as a hub and presents several scenarios on how it might expand in the future.



Scotland's assets for CCS



**Storage
assets**



**Experienced
Oil and Gas
supply chain**



**Existing
infrastructure
in place**



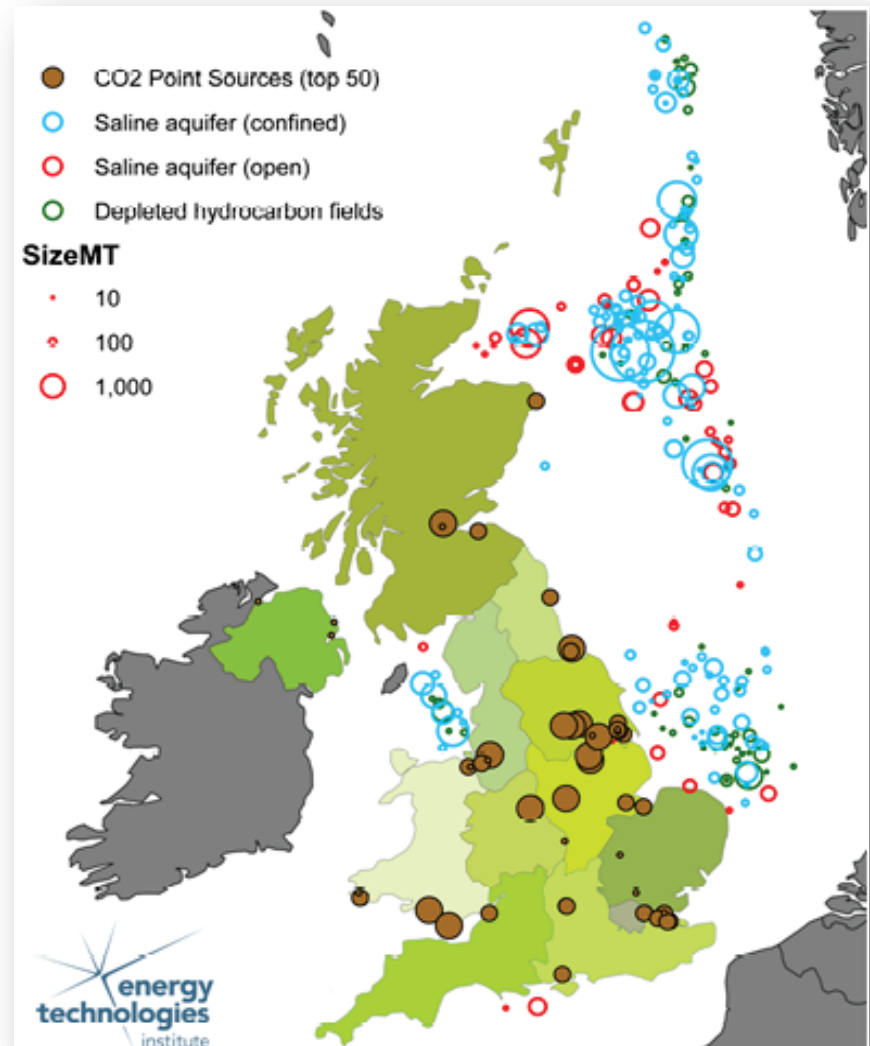
North Sea Storage Assets

Offshore, Scotland has an abundance of storage under the Central North Sea (CNS), including depleted hydrocarbon fields and large saline aquifers.

The potential CO₂ storage capacity in the North Sea is enormous; estimated at **severals tens of Gt**.

There should be sufficient capacity to meet the UK's needs up to 2050 using CNS stores. This would still leave capacity to satisfy a storage demand from North Sea basin countries.

Source: DECC- CCS Roadmap/ Scottish Government / Scottish Enterprise Hub report



The existing Oil and Gas supply chain

The Exploration & Production industry is serviced by a very well developed supply chain. In principle there is **nothing unique** about offshore CCS operations.

The following services are applicable to an offshore CCS industry:

- Seismic
- Reservoir modelling
- Drilling & well services
- Fabricators
- Pipeline & equipment services
- Facilities services (inspection/repair)
- Logistics
- Dive services



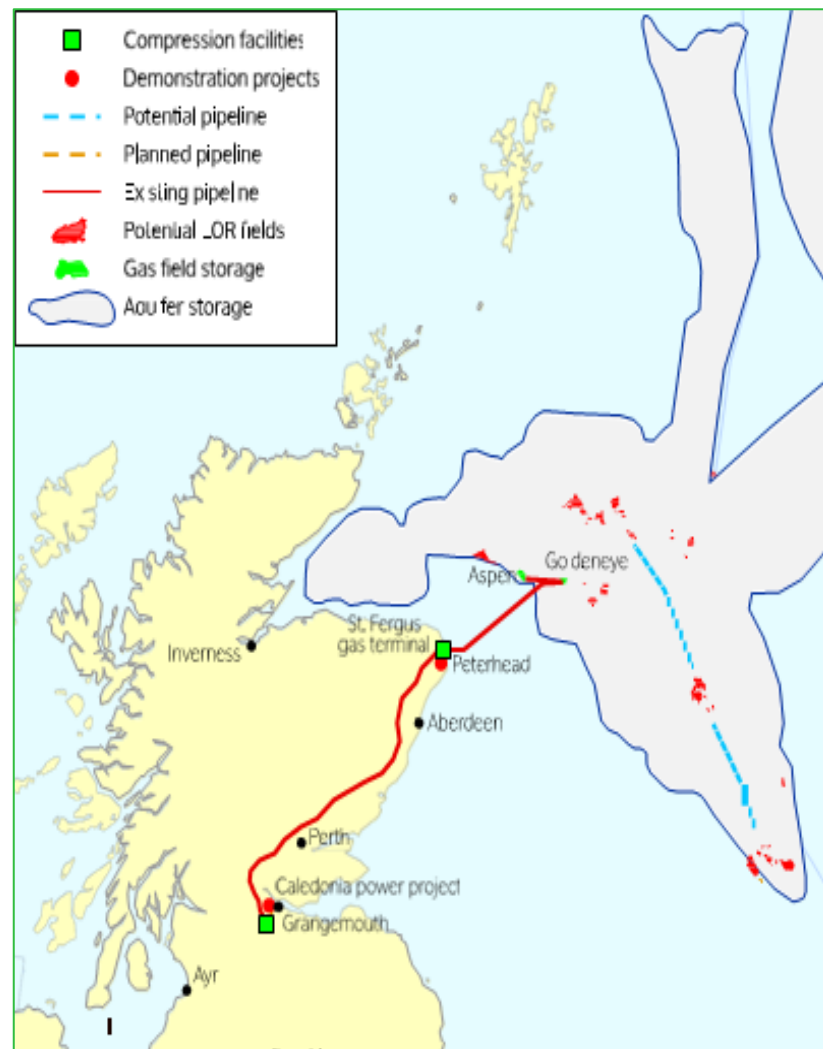
The existing network and installations

Decades of exploration of Oil and Gas in the North Sea has led to an extensive pipeline and infrastructure network on the East Coast and in the North East of Scotland

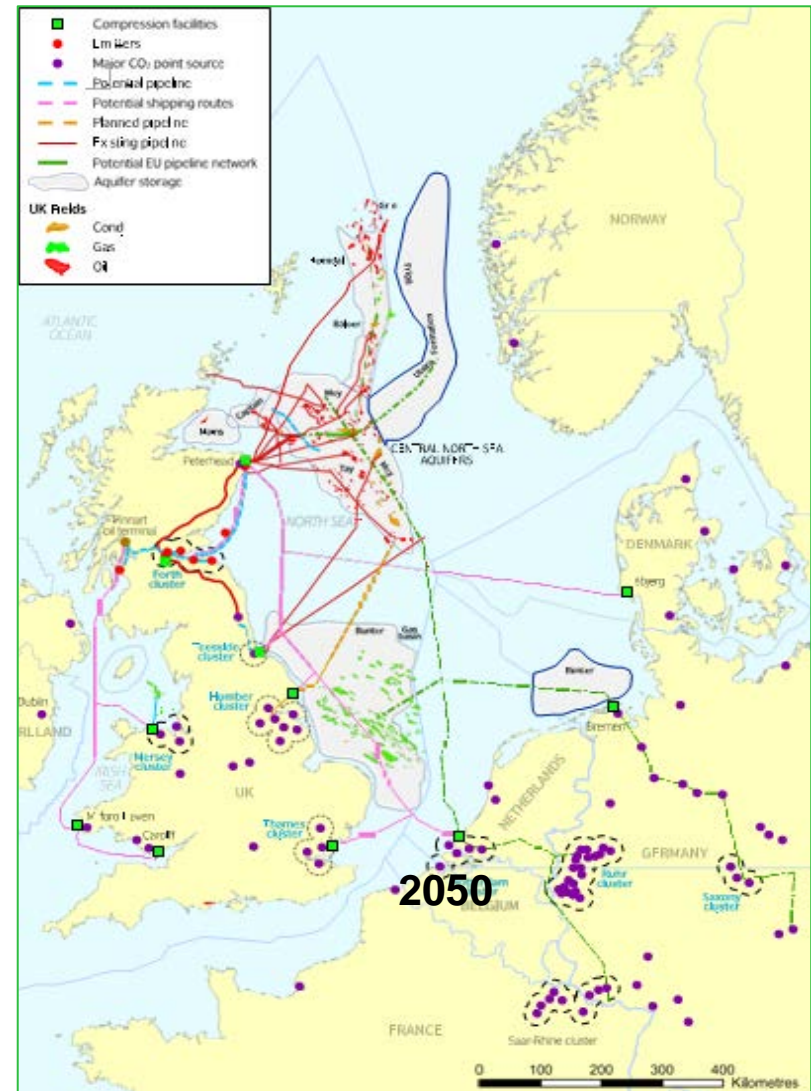
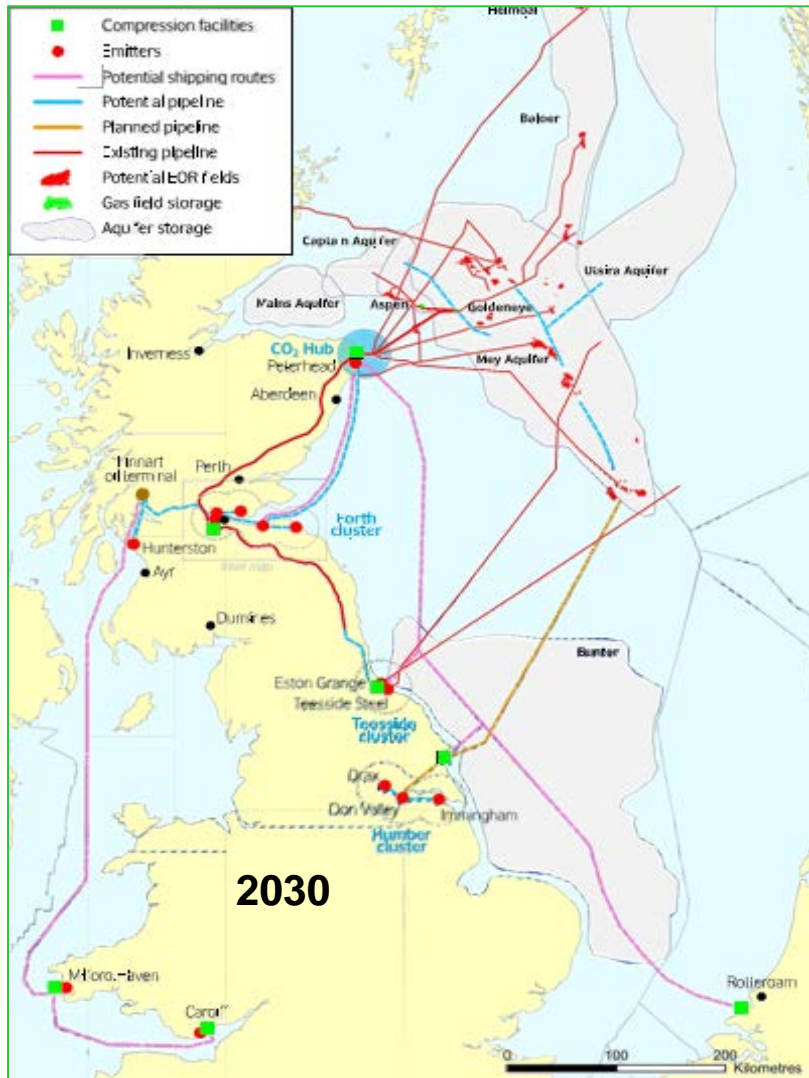
70% of Scotland's CO₂ emissions from power and industry sources are located within 10km of the Feeder 10 pipeline

The Peterhead / St. Fergus area is therefore the ideal location for a CCS Hub in Scotland

It paves the way for a large scale and low cost roll-out of CCS in the UK.



Future scenarios





Thank You